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BIOLOGICAL BULLETIN.

BUNODERA CORNUTA SP. NOV.: A NEW PARASITE FROM THE CRAYFISH AND CERTAIN FISHES OF LAKE CHAUTAUQUA, N. Y.

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A trematode is met frequently at Chautauqua, New York, which though already known seems never to have been critically studied and described. While generically identical with *B. nodulosa* Zeder, of Europe, it cannot be referred to the same species. A form mentioned by Kellicott, '83, and Wright, '84, and Linton, '92, may be identical with it. I have not yet had access to the articles of the first two writers, but Linton, '92, regards the form they mention as identical with the one which he describes from cysts from the ovary of crayfish from Alma, Michigan, which, while it is much like *B. nodulosa* of Europe, he regards as distinct, on account of the two lateral papillary appendages projecting from the oral sucker and of triangular shape. Ward, '94, reports at Ann Arbor, Mich., the form mentioned by Kellicott, Wright and Linton, and considers it probably identical with *B. nodulosa* of Europe. I am at present inclined to think that of these four cases at least that of Linton is identical with the Chautauqua form, and that the others may be. My knowledge of *B. nodulosa* is almost entirely drawn from the account of it in Looss' ('94) admirable monograph of the fish and frog distomes, as I have not had access to specimens of that form. A related trematode is described and figured by Linton, '98, from the intestine of the lake sturgeon, and referred to *B. auriculata* of Wedl, '57. A single specimen of the material on which Linton's account was based has been loaned me by the U. S. National Museum through the kindness of Dr. C. W. Stiles, and from such examination of it as I could make without injuring it I was able to see that externally it is essentially like *B.*

cornuta, excepting as regards the oral papillæ. On this point and in the figures of Linton, there is a divergence from either *B. nodulosa*, for the ventral papillæ are transverse and in the form of a horn, and from the Chautauqua form for the four anterior papillæ characteristic of both *nodulosa* and *cornuta* are wholly wanting. If the absence of these papillæ is a constant character, as at present it must be assumed to be, we then must accept three species for this genus. The coarser features of the organization of the Chautauqua form is described in the following

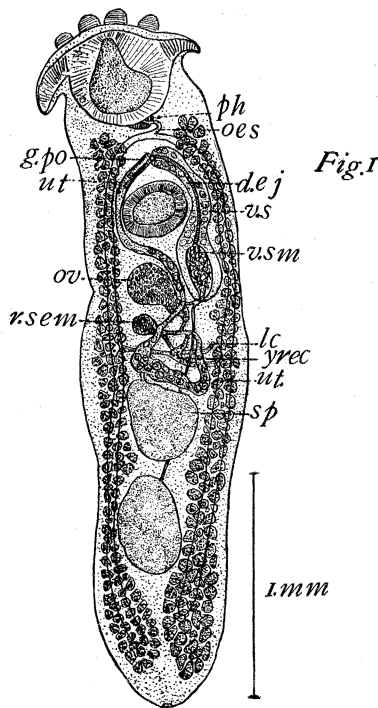


FIG. I. *B. cornuta*, ventral view, compressed, camera lucida $\times 30$. *d.e.j.*, ductus ejaculatorius; *g.po.*, genital pore; *lc.*, Laurer's canal; *oes.*, oesophagus; *ov.*, ovary; *ph.*, pharynx; *r.sem.*, seminal receptacle; *sp.*, spermary; *ut.*, uterus; *v.s.*, ventral sucker; *v.sem.*, seminal vesicle; *y.rec.*, yolk receptacle.

pages. An account of some points in the minuter structure is reserved for a later article. It will be necessary and convenient at least till more is known of *B. auriculata* to adopt a name for the Chautauqua species, and I propose for it the name *B. cornuta*.

The adult stage of *B. cornuta* is found at Chautauqua in the stomachs of black-bass, rock-bass and cat-fish or bull-heads, caught near the Assembly grounds, and earlier stages are found encysted in crayfish, caught near the shore just above the grounds. These localities are near the head of the lake. I have not explored the lake in other places and cannot say how generally the fluke is found in it. The crayfish is clearly the host immediately prior to the fish, as partly digested crayfish are present in the stomachs of fishes where the cysts and the young just escaped flukes are found. The infection of the crayfish is prac-

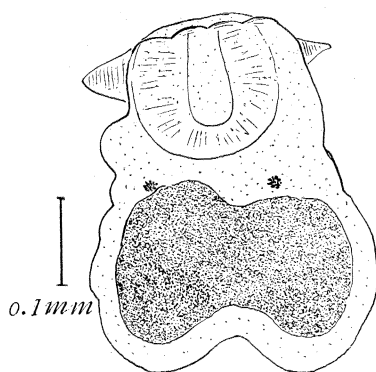


FIG. 2. Young worm still enclosed in cyst, $\times 120$, the shaded area was opaque, and white by reflected light.

tically universal. The flukes are always found encysted, never free. They are located in the parts immediately related to the reproductive system, most constantly in the muscles, especially those running from the thorax to the abdomen, also in the heart itself, and in the gonads. Remoter organs are not infected. This mode of occurrence indicates that the infection may be through the ducts of the gonads, but I have no observations to decide this point. The number of cysts per individual varies considerably, in one case 40 were found, distributed as follows: 25 in the muscles, 6 in the walls of the heart, 9 in the spermary; in another case: 16 in the muscles, none in the heart or gonad; in still another a few were seen in the muscles and none in the heart or gonads. The cysts vary somewhat in size and structure with the season. In early July they are 0.9 mm. in diameter and consist of a soft fleshy grayish enveloping portion about 0.2

mm. thick, enclosing a central mass, dark yellowish-brown and hard, as if perhaps chitinous, of a diameter of 0.5 mm. By manipulating the cysts with little knives made from specially ground needles I found it possible to extract from them a very immature fluke (see Fig. 2) recognizable as *B. cornuta* by its oral sucker. A pair of eyes is present, but the inner organization showed no traces. I suppose the dark granular mass at the posterior end to be a supply of food for the developing worm. Some of the cysts differ by having in place of the hard granular inner cyst a thin homogeneous covering, enclosing a worm so

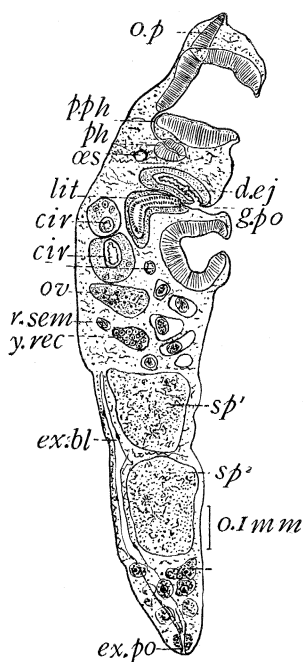


FIG. 3. Sagittal section, cam. luc. $\times 60$. *cir.*, cirrus; *ex.bl.*, excretory bladder; *o.p.*, oral papilla; *pph.*, pre-pharynx.

much more advanced in development, that the alimentary and excretory systems were formed and the genital organs well advanced. In early August cysts having a diameter of 1 mm. or over were found which contained fully matured worms, containing embryos numerous enough to impart a distinctly brown tinge to the parent. These facts are of very considerable interest,

for they indicate that the young worm develops actively during encystment, and that here self-fertilization must take place. A fuller study of this point is desirable.

In the fish the parasite has been found only in the stomach. Both cysts separated from the crayfish, and the free worms are found. *B. nodulosa* is reported from the intestine of fishes and *B. auriculata* is also an intestinal parasite.

The body form is nearly cylindrical, in contrast with the elongate neck and almost leaf-shaped body of *B. nodulosa*. This contrast is well seen by comparing Figs. 1 or 7 with Fig. 10 of Looss. The latter is a young stage in which the vitellaria are not as yet developed, while both of the Chautauqua specimens possess them and the uterus contains eggs. My specimens differ considerably in length, owing to the fact that they go on growing

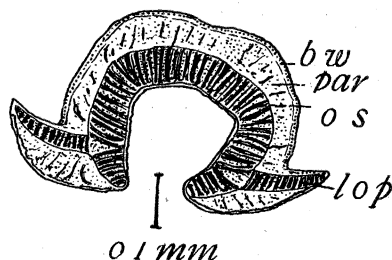


FIG. 4. Transverse section passing through the oral sucker in the level of the lateral processes. Cam. luc. $\times 50$. *l.o.p.*, lateral oral papilla; *b.w.*, body wall, *par.*, parenchyma; *o.s.*, oral sucker.

longer after maturity. The longest one that I have seen measured 3.0 mm. in length by 0.9 mm. in width (in the preserved and mounted state). I have seen specimens fully developed sexually measuring only 0.9 mm. in length by 0.2 mm. in width. The oral sucker is very large, so that it fills completely the anterior end of the body. It is furnished with remarkable muscular processes, six in number which give the worm a very characteristic appearance. Four of these processes or papillæ are blunt, and extend forward from the dorsal and anterior end of the body. In a ventral view of the animal they are seen extending slightly beyond a thin layer of the body wall which forms the anterior boundary of the body. The other two papillæ are at the posterior level of the oral sucker, and ventral, on the opposite

side from the four blunt anterior papillæ, and they are extended transversely to the animal. In form they are tapering and pointed, and slightly curved backward, in the form of a horn, extending considerably beyond the contour of the side of the animal. The oral sucker itself has a diameter of 0.4 mm. The ventral sucker, while large, is smaller than the oral sucker, its diameter being 0.3 mm. Its position in Fig. 1 is strikingly far forward; in Fig. 7 it is more nearly in the center of the body. This difference is due to contraction of the neck in Fig. 1, shown also by the winding course of the œsophagus of that specimen. The genital pore is located in front of and near to the ventral sucker, in the middle line. Eyes are present in younger specimens, but older ones do not possess them, though in these it is

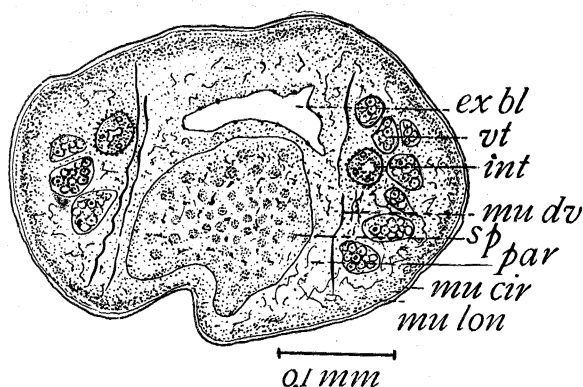


FIG. 5. Transverse section in level of the posterior spermary. Cam. luc. $\times 115$. *vt.*, vitellaria; *mu.d.v.*, dorsiventral muscle; *mu.cir.*, circular muscle of the body wall; *mu.lon.*, longitudinal muscle of the body wall.

possible to find scattered grains of pigment in the region of the pharynx, indicating their late disappearance. Looss represents eyes in both the specimens figured by him, so that if they are not exceptional cases, the eyes persist to a much later time in the life history of *B. nodulosa* than of *B. cornuta*.

The body wall presents the usual cuticle, destitute of spines. The usual muscle layers are present, the fibers of the outer circular layer are very fine indeed; those of the longitudinal and oblique layers are exceptionally large. Parenchymatous muscle is somewhat specially collected in each side of the body running dorso-

ventrally, and marking off a lateral area, containing the vitellaria and the intestine, from the center (see Fig. 5). There are no horizontal parenchyma muscles. Cells of the parenchyma directly underlying the body wall are especially numerous and glandular in appearance, as often in trematodes.

The oral sucker opens widely downwards and forwards. It is composed of the usual muscular masses, enclosed within a fine structureless membrane marking it off from the parenchyma. The detailed structure of the papillæ is indicated in Fig. 4, which is a camera lucida drawing from a section passing through the

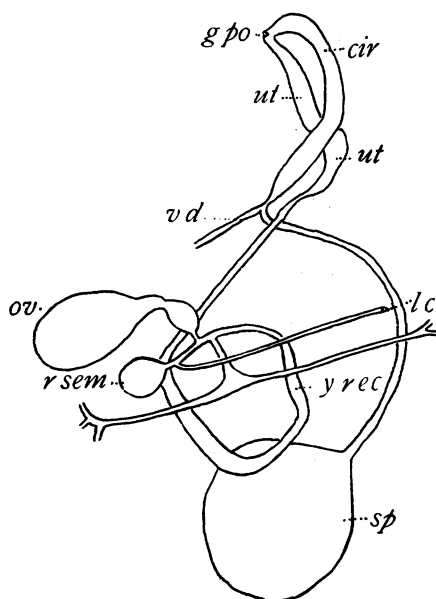


FIG. 6. General view of the reproductive organs, seen dorsally.

oral sucker in the level of the lateral papillæ and through their length. Sections through the four anterior papillæ show the same things. The wall of the oral sucker, consisting of a layer of parenchymatous tissue and masses of radial fibers, is pushed out at the bases of the papillæ, the connective tissue portion being directly continuous and the muscle fibers pushed aside at that point, and passes up to the summit of the papilla, a new set of radial fibers being added in the papilla similar to those of the general wall of the sucker. The papillæ are thus not merely

surface features of the animal, but deep-seated in their origin, and are entitled to be regarded as of considerable importance from a taxonomic point of view.

The lateral papillæ are unmistakable organs not likely to be overlooked by an observer, whereas the ventral papillæ of *B. nodulosa* are inconspicuous and might easily escape notice, a point discussed by Looss ('94, p. 34). In *B. auriculata* I looked very closely for the dorsal papillæ without finding them and I am

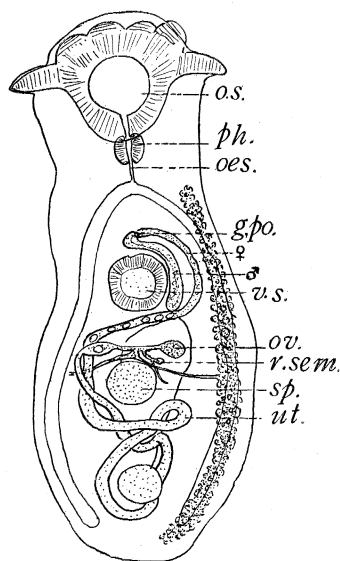


FIG. 7. Ventral view of a specimen in which the uterus is most fully developed, the vitellaria are omitted from the right side.

convinced that they are absent from the specimen I saw, in which respect my observations confirm those of Linton as indicated in his figures, '98, Pl. XLV., Figs. 1-7.

There is a short pre-pharynx, a small pharynx, about 0.05 mm. long, a short œsophagus, its walls very strongly muscular and surrounded by glandular cells. The forking of the intestines is thus close to the pharynx, a point different from *B. nodulosa*. The intestines are simple and long, reaching to near the hinder end of the body. They are lined with epithelium cells whose outer ends are elongate and whose tips extend into the cavity of the organ. Circular and longitudinal muscle fibers are present in the wall.

The excretory pore is terminal. Close in front of it is the excretory bladder, which in sections can be seen running dorsally forward at least as far as the level of the front of the anterior testis (see Figs. 2, 5). I have not been able to recognize more than the most posterior portion in living animals. According to Looss there is in *B. nodulosa* a bladder wholly posterior to the hinder testis containing concretions, and from which vessels run forward on either side. I have not seen such concretions in *B. cornuta* and the bladder is much more extensive than that.

There are two large testes, 0.3 mm. across, lying one directly in front of the other. In *B. nodulosa* the testes are smaller, farther apart and oblique. The testes are crowded with active sperm cells, many of them in the last stages of spermatogenesis, and with numerous fully formed spermatozoa. The seminal vesicle and spermatheca are also filled with them.

Long and slender vasa deferentia run dorsally to the other genital organs, and meet at the posterior end of the large cirrus sack which is located some distance behind the posterior border of the ventral sucker. The cirrus sack is very large indeed, much larger than in *B. nodulosa*. It has a definite outer wall, strongly muscular, enclosing a tubular passage subdivided into two portions, a posterior thin-walled part, the seminal vesicle, and an anterior ductus ejaculatorius. This latter is surrounded by glandular "prostate" cells, is very strongly muscular, having both circular and longitudinal fibers. The ductus ejaculatorius is not coiled. I do not know whether it is eversible or not.

The ovary is generally located on the right side, but not infrequently it is found on the left (cf. Figs. 1 and 7). It is always near the ventral sucker, a large and conspicuous organ. There is a short ciliated oviduct, soon joined by first a duct from the seminal receptacle, then one from the yolk receptacle. Certain glandular-looking cells which lie around the oviduct may perhaps represent a shell gland, but a distinct and well-marked organ is not present. Nearly all of my specimens appear to be quite young, and though the uterus contains eggs it is not fully developed. In one, however (Fig. 7), the uterus is longer and evidently more as in fully matured individuals. In this case the uterus is distinctly tubular and winds down and back, passing

between the testes in its course, in *B. nodulosa* the uterus is a large sack containing old and young eggs indiscriminately, the uterus is saccular even in young individuals of *B. nodulosa*, as seen in Looss' Fig. 10 of a specimen before egg production has begun. The terminal part of the uterus differs decidedly from the rest so as to form an entirely distinct though continuous organ (cf. Fig. 2.) Its wall is very thick indeed and consists of a strong muscular coat quite unlike the wall of the deeper parts of the tube, and within the wall is furnished with a clothing of very peculiar numerous long slender bluntly ending processes which are free at tip in the cavity of the organ. These structures do not look like cilia, being too blunt. They do not seem certainly to be protoplasmic, at least the bases do not seem—as far as I have been able to study them—to be nucleated cells, as we should expect. The histological structure of this part will have to be left for a subsequent study. This organ is further surrounded by parenchyma cells having much the same appearance as the prostate cells of the cirrhus. The eggs measure 0.07 mm. in length instead of 0.1 mm. as in *B. nodulosa*.

Laurer's canal is present, passes dorsally and opens to the exterior on the left side. The seminal receptacle is large and distinct; it lies close to and just behind the ovary. It is in all cases of adults filled with spermatozoa. The vitellaria are large, and located as above described laterally and so as partly to envelope the intestines. They extend from near the pharynx to near the hind end of the body and consist of very numerous small follicles uniformly distributed. A duct from each crosses the body in front of the anterior testis and behind the ovary and seminal receptacle and the two joining from the yolk receptacle which reaches the oviduct by a short duct close to the ovary.

The points made in the foregoing pages are summarized in the following table of comparisons :

	<i>B. cornuta.</i>	<i>B. nodulosa.</i>
Total length,	3 mm.,	3 mm. Looss, 4.5 mm. Olsson.
Body form,	cylindrical,	leaf-shaped.
Neck,	not prominent,	prominent and distinct.

Lateral papillæ,	transverse and hook-shaped,	longitudinal and blunt, not hook-shaped.
Eyes,	not persistent,	persistent in adult.
Œsophagus,	short,	long.
Excretory bladder,	long,	short.
Testes,	close together in median line,	wide apart, and oblique.
Uterus,	tubular,	saccular.
Ova,	0.07 mm. long,	0.1 mm. long,
Residing,	in stomach,	in intestine of host.

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SAINT PAUL, MINN., March 10, 1903.

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